12-lead EKG

Overview of Steps

1. Things to consider before the 12-lead
    a. Likelihood of MI based on symptoms
    b. Assess rhythm in lead II
        i. Determine if immediate intervention is indicated
        ii. Consider dysrhythmias prone to lethal arrhythmias
        iii. Determine if rhythm likely to indicate MI
2. Place leads and capture 12-lead
3. Assess for MI
    a. Evaluate ST segments
    b. Rule out STEMI mimics
    c. Assess for OMI patterns
    d. Identify area of heart affected & corresponding blood supply
        i. STEMI paradigm
        ii. OMI paradigm
    e. Adjust treatment plan & consider possible complications
        i. STEMI paradigm
        ii. OMI paradigm
4. Perform additional actions if needed
    a. Right-sided EKG
    b. Posterior EKG
5. Evaluate any additional findings
    a. 12-lead patterns with predisposition to lethal arrhythmias
    b. Bundle branch blocks
    c. Axis deviation
    d. R wave progression
    e. Hypertrophy
    f. Strain patterns

Additional Tools & Resources
(all free, all great)

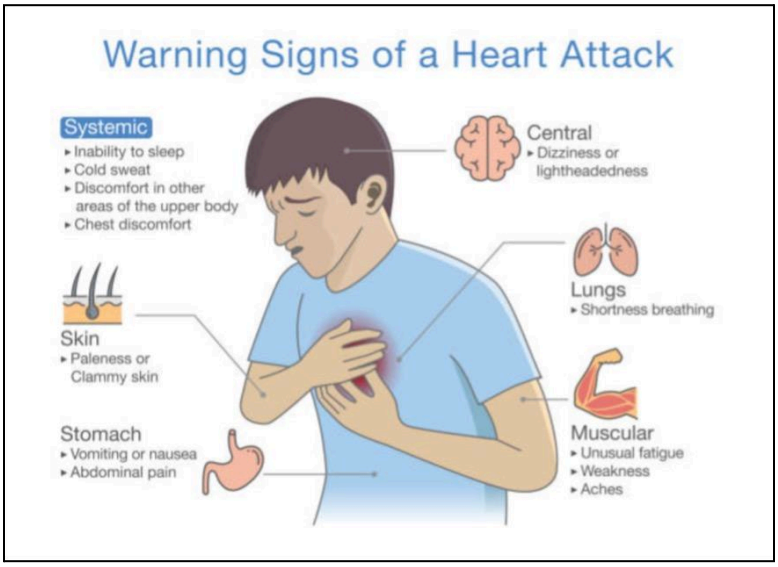
OMI Guide – website, but consider using as a progressive web app
OMI Toolbox – app available for both android and apple
Ecgbook.com – free resource, we borrowed many of their photos
Nelson's EKG Book – not explicitly referenced here, but a great free EKG resource
Dr. Smith's EKG Blog – for further details and cases on most things mentioned here

Created with love by Rykerr Medical
rykerrmedical.com

Return to Contents

Annotated Steps

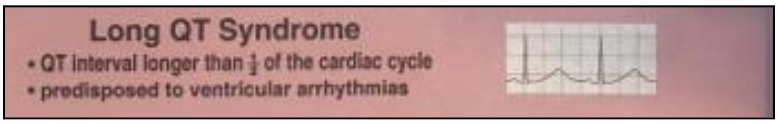
1. Things to consider before the 12-lead
    a. Likelihood of MI based on symptoms

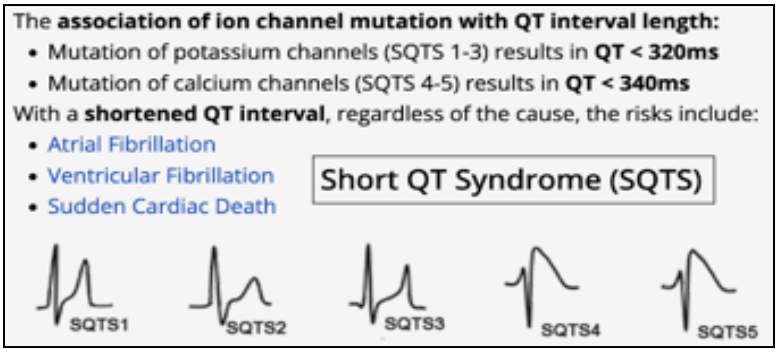


- EDACS Score (or HEART Score)
    - OMI Toolbox App Symptoms (apple, android)
    - MDCalc

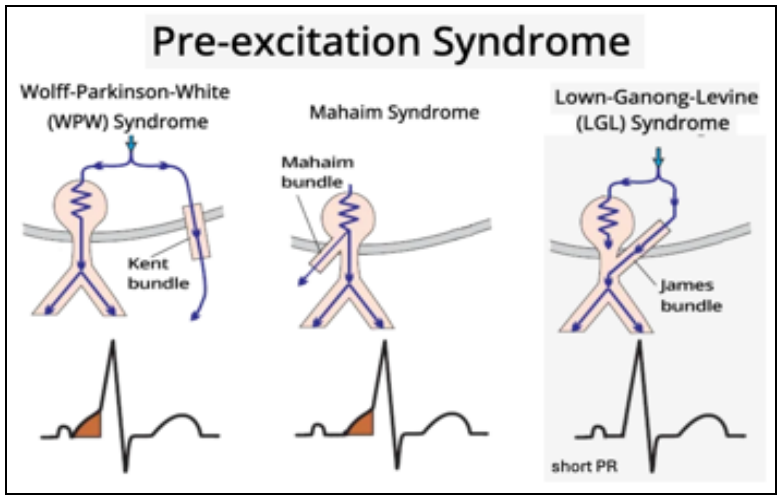
b. Assess rhythm in lead II
    i. Determine if immediate intervention is indicated
        - ACLS Bradycardia Algorithm (web or pdf)
        - ACLS Tachycardia Algorithm (web or pdf)

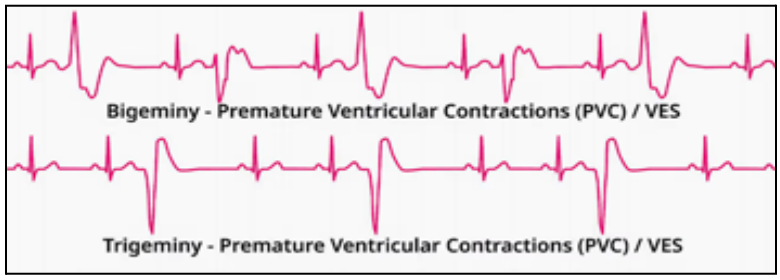
    ii. Consider dysrhythmias prone to lethal arrhythmias




The association of ion channel mutation with QT interval length:
• Mutation of potassium channels (SQTS 1-3) results in QT < 320ms
• Mutation of calcium channels (SQTS 4-5) results in QT < 340ms
With a shortened QT interval, regardless of the cause, the risks include:
• Atrial Fibrillation
• Ventricular Fibrillation
• Sudden Cardiac Death
Short QT Syndrome (SQTS)
SQTS1
SQTS2
SQTS3
SQTS4
SQTS5

Return to Contents



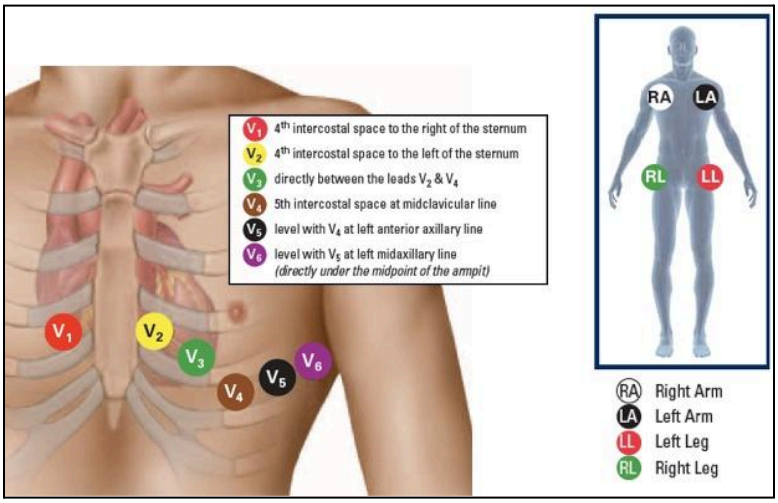


iii. Determine if rhythm likely to indicate MI

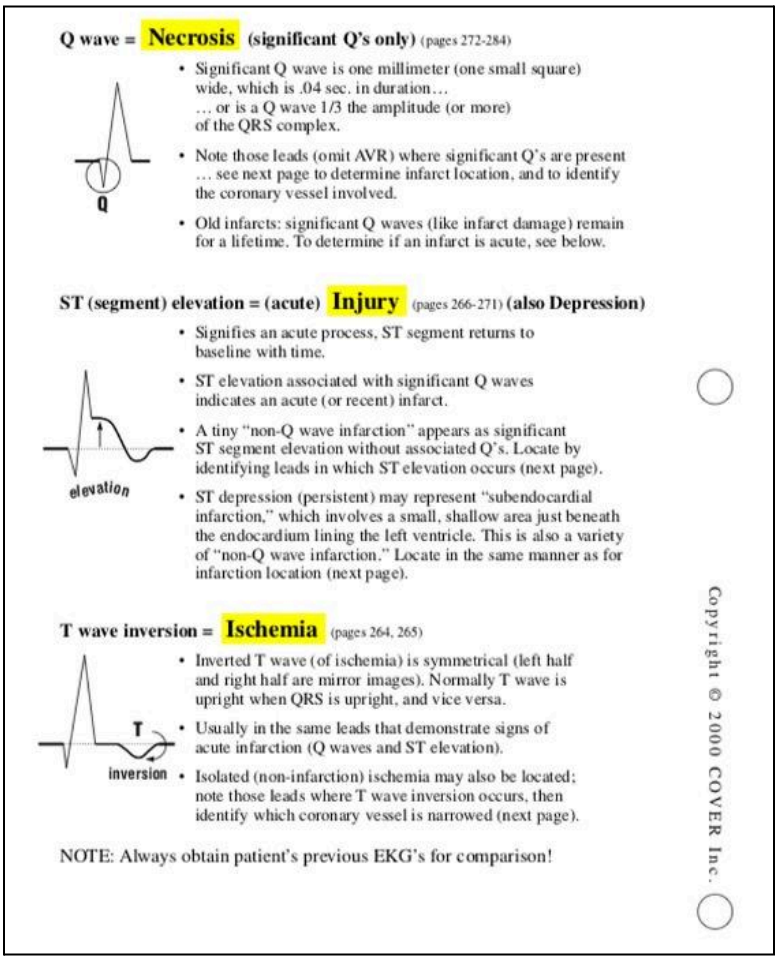
abnormal EKG rhythm	**likelihood of an MI in general based on the presenting EKG**
sinus tachycardia	low/ moderate; most common rhythm in MI, h/e there are many, many causes…
sinus bradycardia	moderate if no other obvious cause
atrial fibrillation	moderate if new onset *and* no other obvious cause
ventricular tachycardia	high, but fix it before going down the 12-lead rabbit hole…
ventricular fibrillation	high, but fix it before going down the 12-lead rabbit hole…
AV block (all types)	moderate if new onset, likelihood increases with severity of block
junctional rhythms (all types)	moderate with new onset
PVCs (with any rhythm)	low in general; moderate/ high if frequent or increasing in frequency

Return to Contents

2. Place leads and capture 12-lead


V1 4th intercostal space to the right of the sternum
V2 4th intercostal space to the left of the sternum
V3 directly between the leads V2 & V4
V4 5th intercostal space at midclavicular line
V5 level with V4 at left anterior axillary line
V6 level with V5 at left midaxillary line
(directly under the midpoint of the ampit)
RA
LA
RL
LL
Right Arm
Left Arm
Left Leg
Right Leg

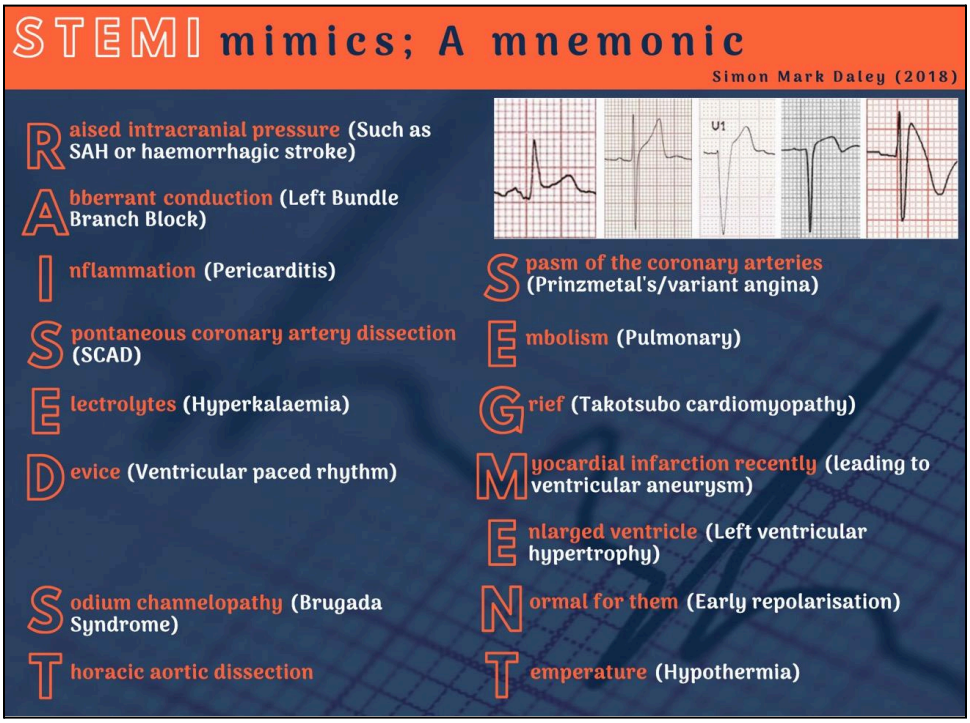
3. Assess for MI
    a. Evaluate ST segments


Q wave = Necrosis (significant Q's only) (pages 272-284)
• Significant Q wave is one millimeter (one small square) wide, which is .04 sec. in duration…
… or is a Q wave 1/3 the amplitude (or more) of the QRS complex.
• Note those leads (omit AVR) where significant Q's are present … see next page to determine infarct location, and to identify the coronary vessel involved.
• Old infarcts: significant Q waves (like infarct damage) remain for a lifetime. To determine if an infarct is acute, see below.
Q
ST (segment) elevation = (acute) Injury (pages 266-271) (also Depression)
• Signifies an acute process, ST segment returns to baseline with time.
• ST elevation associated with significant Q waves indicates an acute (or recent) infarct.
• A tiny "non-Q wave infarction" appears as significant ST segment elevation without associated Q's. Locate by identifying leads in which ST elevation occurs (next page).
• ST depression (persistent) may represent "subendocardial infarction," which involves a small, shallow area just beneath the endocardium lining the left ventricle. This is also a variety of "non-Q wave infarction." Locate in the same manner as for infarction location (next page).
elevation
T wave inversion = Ischemia (pages 264, 265)
• Inverted T wave (of ischemia) is symmetrical (left half and right half are mirror images). Normally T wave is upright when QRS is upright, and vice versa.
• Usually in the same leads that demonstrate signs of acute infarction (Q waves and ST elevation).
• Isolated (non-infarction) ischemia may also be located; note those leads where T wave inversion occurs, then identify which coronary vessel is narrowed (next page).
T
inversion
NOTE: Always obtain patient's previous EKG's for comparison!
Copyright © 2000 COVER Inc.

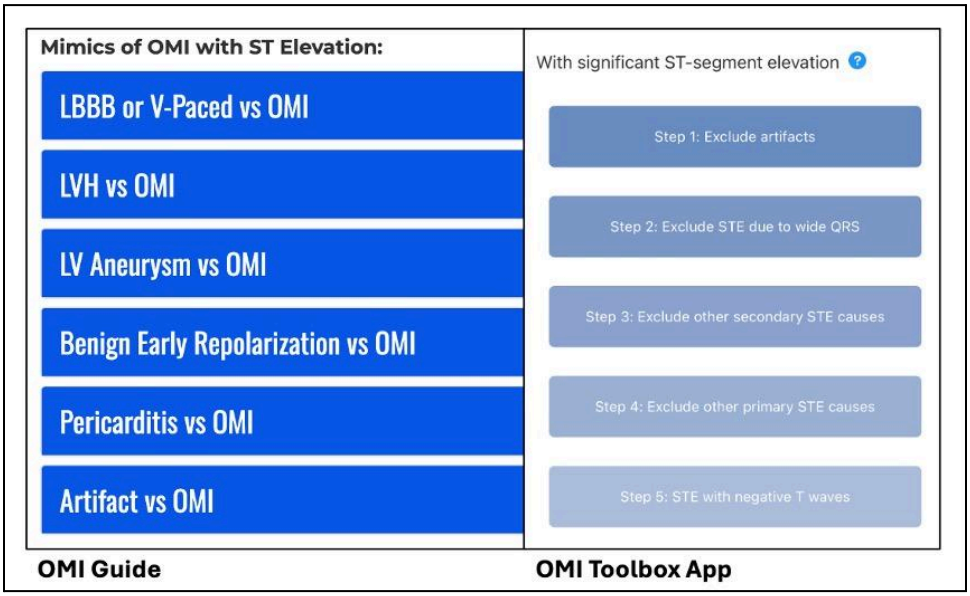
*asymmetric T-wave inversion in V1-V3 may be benign, see (web or pdf) for details

Return to Contents

b. Rule out STEMI mimics


STEMI mimics; A mnemonic
Simon Mark Daley (2018)
Raised intracranial pressure (Such as SAH or haemorrhagic stroke)
Aberrant conduction (Left Bundle Branch Block)
Inflammation (Pericarditis)
Spontaneous coronary artery dissection (SCAD)
Electrolytes (Hyperkalaemia)
Device (Ventricular paced rhythm)
Sodium channelopathy (Brugada Syndrome)
Thoracic aortic dissection
Spasm of the coronary arteries (Prinzmetal's/variant angina)
Embolism (Pulmonary)
Grief (Takotsubo cardiomyopathy)
Myocardial infarction recently (leading to ventricular aneurysm)
Enlarged ventricle (Left ventricular hypertrophy)
Normal for them (Early repolarisation)
Temperature (Hypothermia)

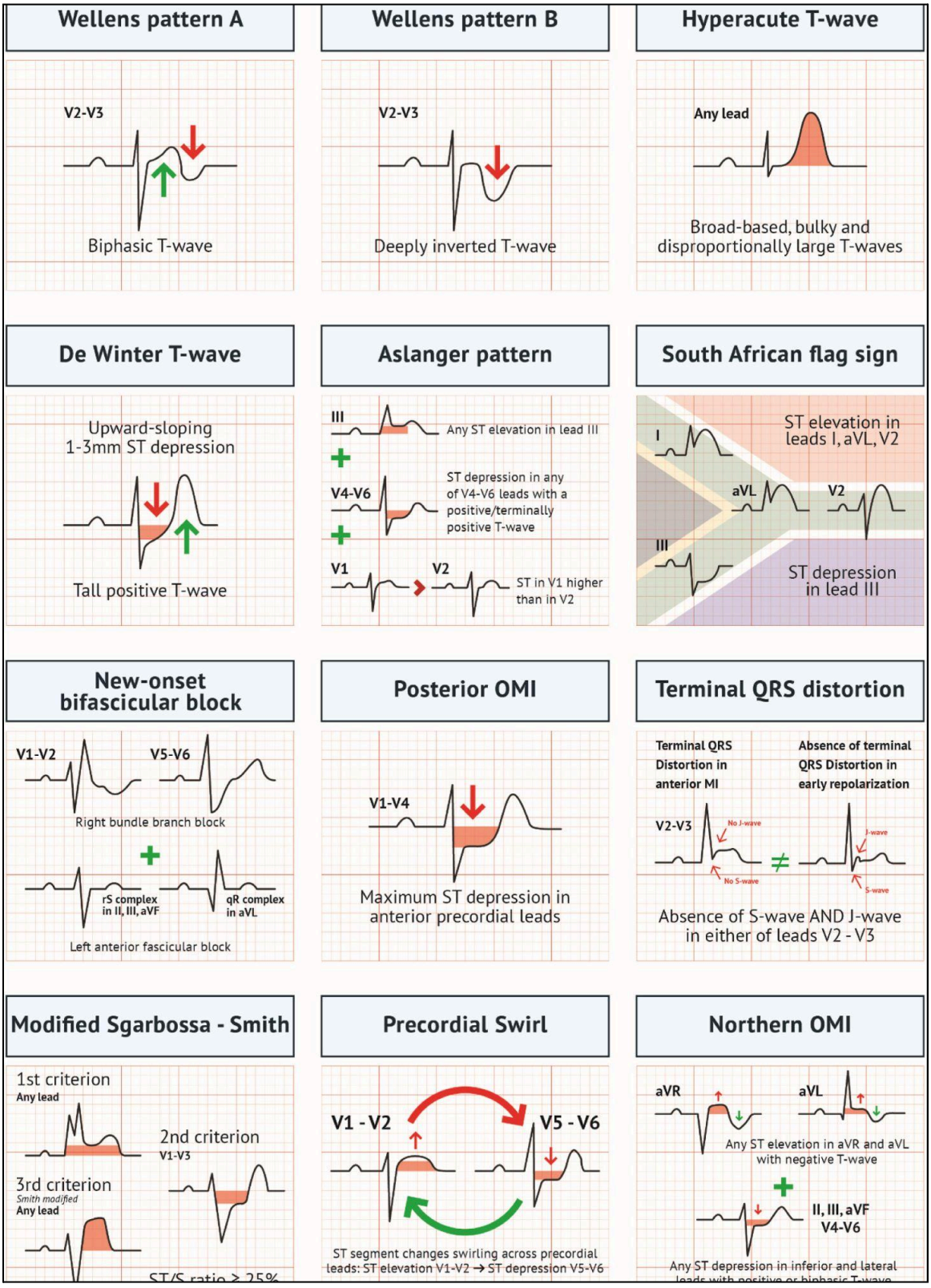
*and follow this link or download here to see the full pdf document/ explanations


Mimics of OMI with ST Elevation:
LBBB or V-Paced vs OMI
LVH vs OMI
LV Aneurysm vs OMI
Benign Early Repolarization vs OMI
Pericarditis vs OMI
Artifact vs OMI
With significant ST-segment elevation
Step 1: Exclude artifacts
Step 2: Exclude STE due to wide QRS
Step 3: Exclude other secondary STE causes
Step 4: Exclude other primary STE causes
Step 5: STE with negative T waves
OMI Guide
OMI Toolbox App

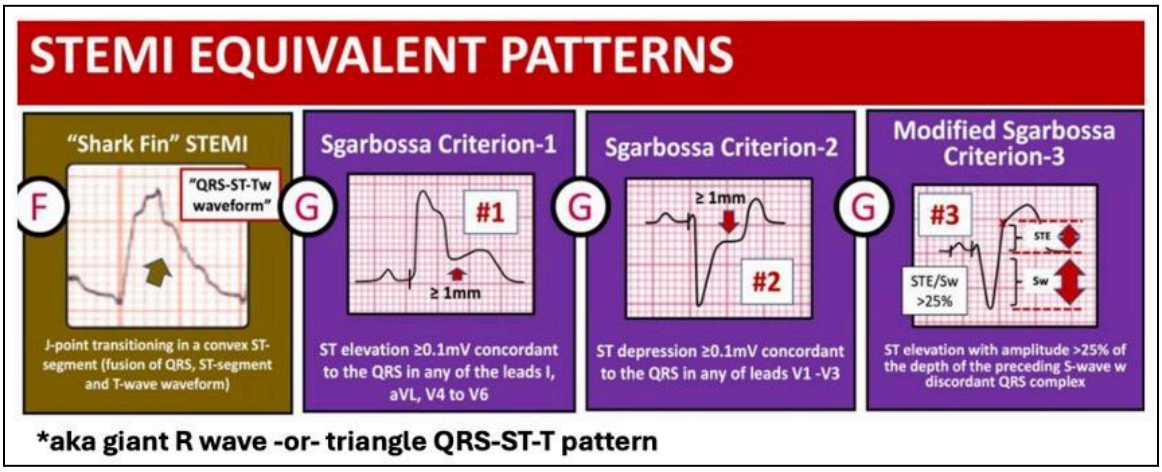
*OMI Guide & OMI Toolbox (apple, android)

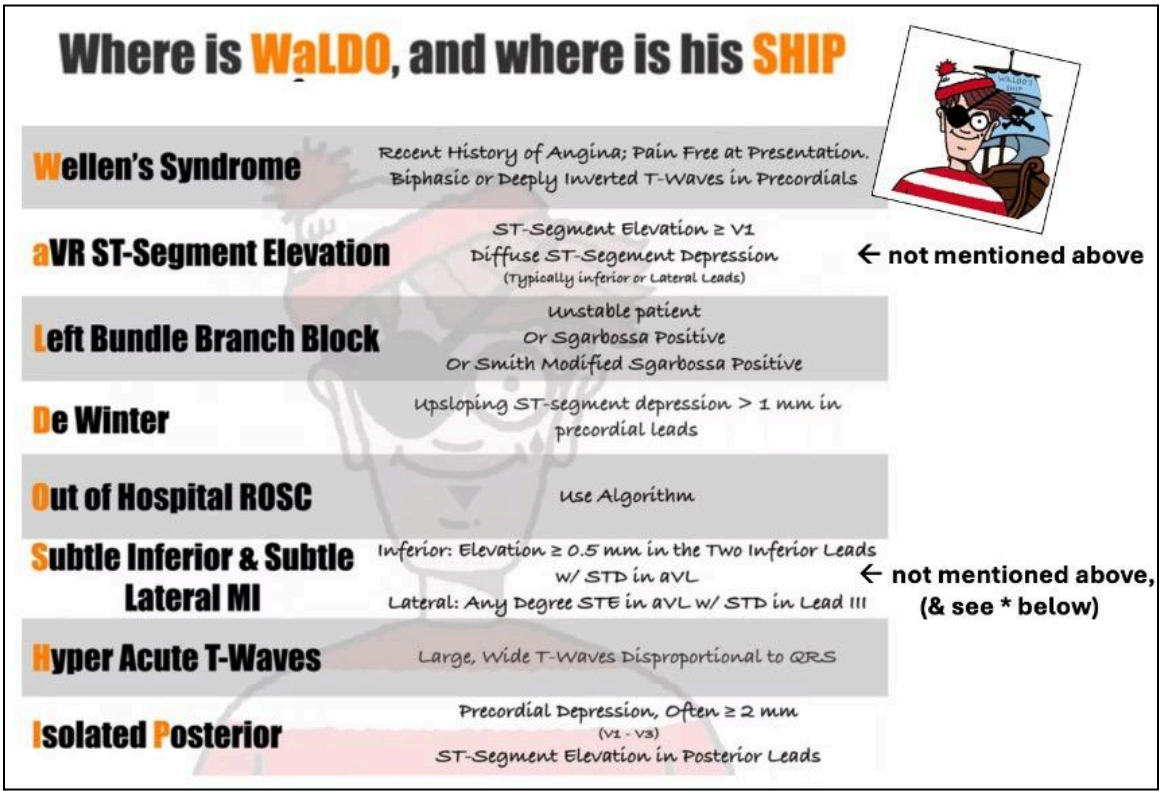
Return to Contents

c. Assess for OMI patterns
- also consider the OMI Guide to review these patterns



Return to Contents


STEMI EQUIVALENT PATTERNS
"Shark Fin" STEMI
F
"QRS-ST-Tw waveform"
J-point transitioning in a convex ST-segment (fusion of QRS, ST-segment and T-wave waveform)
G
Sgarbossa Criterion-1
#1
≥ 1mm
ST elevation ≥0.1mV concordant to the QRS in any of the leads I, aVL, V4 to V6
G
Sgarbossa Criterion-2
≥ 1mm
#2
ST depression ≥0.1mV concordant to the QRS in any of leads V1 -V3
G
Modified Sgarbossa Criterion-3
#3
STE
Sw
STE/Sw >25%
ST elevation with amplitude >25% of the depth of the preceding S-wave w discordant QRS complex
*aka giant R wave -or- triangle QRS-ST-T pattern

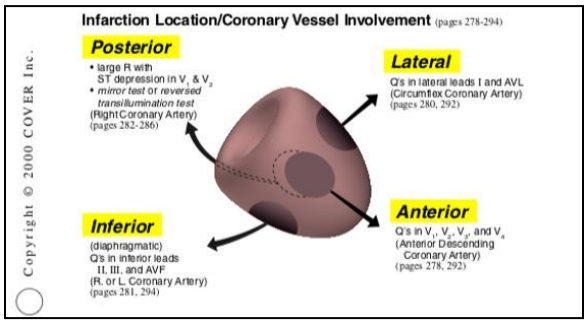

Where is WaLDO, and where is his SHIP
Wellen's Syndrome
Recent History of Angina; Pain Free at Presentation.
Biphasic or Deeply Inverted T-Waves in Precordials
aVR ST-Segment Elevation
ST-Segment Elevation ≥ V1
Diffuse ST-Segement Depression
(Typically inferior or Lateral Leads)
← not mentioned above
Left Bundle Branch Block
Unstable patient
Or Sgarbossa Positive
Or Smith Modified Sgarbossa Positive
De Winter
Upsloping ST-segment depression > 1 mm in precordial leads
Out of Hospital ROSC
Use Algorithm
Subtle Inferior & Subtle Lateral MI
Inferior: Elevation ≥ 0.5 mm in the Two Inferior Leads w/ STD in aVL
Lateral: Any Degree STE in aVL w/ STD in Lead III
← not mentioned above, (& see * below)
Hyper Acute T-Waves
Large, Wide T-Waves Disproportional to QRS
Isolated Posterior
Precordial Depression, Often ≥ 2 mm
(V1 - V3)
ST-Segment Elevation in Posterior Leads

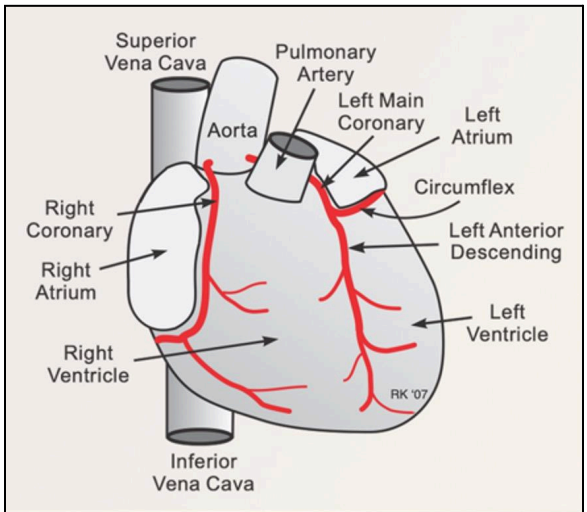
*there is also an anterior subtle STEMI, best assessed using this tool on MDCalc

Return to Contents

d. Identify area of heart affected & corresponding blood supply
    i. STEMI paradigm

I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral


Infarction Location/Coronary Vessel Involvement (pages 278-294)
Posterior
• large R with ST depression in V1 & V2
• mirror test or reversed transillumination test
(Right Coronary Artery)
(pages 282-286)
Lateral
Q's in lateral leads I and AVL
(Circumflex Coronary Artery)
(pages 280, 292)
Inferior
(diaphragmatic)
Q's in inferior leads II, III, and AVF
(R. or L. Coronary Artery)
(pages 281, 294)
Anterior
Q's in V1, V2, V3, and V4
(Anterior Descending Coronary Artery)
(pages 278, 292)
Copyright © 2000 COVER Inc.



Anatomic Region of Heart	*Coronary Artery (most likely associated)*
Inferior	Right coronary
Anteroseptal	Left anterior descending
Anteroapical	Left anterior descending (distal)
Anterolateral	Circumflex
Posterior	Right coronary artery

Return to Contents

ii. OMI paradigm

pattern seen	blood supply	area affected
wellens	re-perfused, prox. left ant. descending (LAD)	anterior
hyperacute T-waves	(correlate with leads where changes are seen)	(varies)
de winter T-waves	prox. left ant. descending (LAD)	anterior
aslanger pattern	right coronary (RCA) left circumflex (LCX)	inferior
south african Flag	first diagonal branch of left ant. descending (LAD)	anterolateral/ high lateral
new onset bifasc. block w/ RBBB	prox. left ant. descending (LAD)	anterior
posterior OMI	left circumflex (LCX) right coronary (RCA)	posterior
terminal QRS distortion (V2-V3)	left ant. descending (LAD)	anterior
sgarbossa	(correlate with leads where changes are seen)	(varies)
precordial swirl	prox. left ant. descending (LAD)	anterior
northern OMI	left ant. descending (LAD) & 1st diagonal bifurcation	anterior
shark fin	prox. left ant. descending (LAD)	anterior
aVR ST elevation	left main, prox. left ant. descending (LAD) or 3x vessel	anterior & lateral (L main) anterior & septal (LAD) can be global (multi vessel)
subtle stuff	(correlate with leads where changes are seen)	most likely inferior or lateral

Return to Contents

e. Adjust treatment plan & consider possible complications

i. STEMI paradigm

area affected	blood supply	other structures that may be affected	adjust treatment	possible complications
inferior	right coronary (RCA) – highest % left coronary (left main) – low % codominance – low-mid%	vagus nerve; conduction system in general, SA & AV nodes specifically; right ventricle	caution with nitrates and rule out RV involvement, fluids for hypotension, consider right-sided view	hypotension, RV infarct; bradycardia (sinus brady or AV blocks), atrial fibrillation, junctional rhythms, PVCs
lateral	left circumflex (LCX) (and other branches of LAD)	left atrium, papillary muscles, conduction system in general	consider listening to HTs	papillary muscle rupture/ mitral regurgitation
septal	anterior descending (LAD)	papillary muscles, bundle branches, AV node	consider listening to HTs	acute VSD; BBBs, AV block
anterior	anterior descending (LAD)	conduction system in general, including bundle branches	caution with fluid administration if needed,	LV dysfunction/ pulmonary edema, cardiogenic shock, LV thrombus, acute VSD; AV block (if present) progression, atrial fibrillation, ventricular dysrhythmias
posterior	posterior descending (PDA), from: right coronary (RCA) - more likely with inferior involvement left circumflex (LCX) – more likely when isolated posterior	SA node, right ventricle, papillary muscles	rule out RV involvement, consider posterior view, consider inferior involvement consider listening to HTs	papillary muscle rupture/ mitral regurgitation; AV block
right ventricle	right coronary (RCA)	inferior or lateral wall MI, AV node	avoid nitrates, aggressive fluid resuscitation	cardiogenic shock, tricuspid regurgitation; AV block, bradycardia;
*basically any type of MI (when broken down geographically like this) *might* affect both the bundle branches and the AV node, so we've only noted them above when risk is high				

ii. OMI paradigm

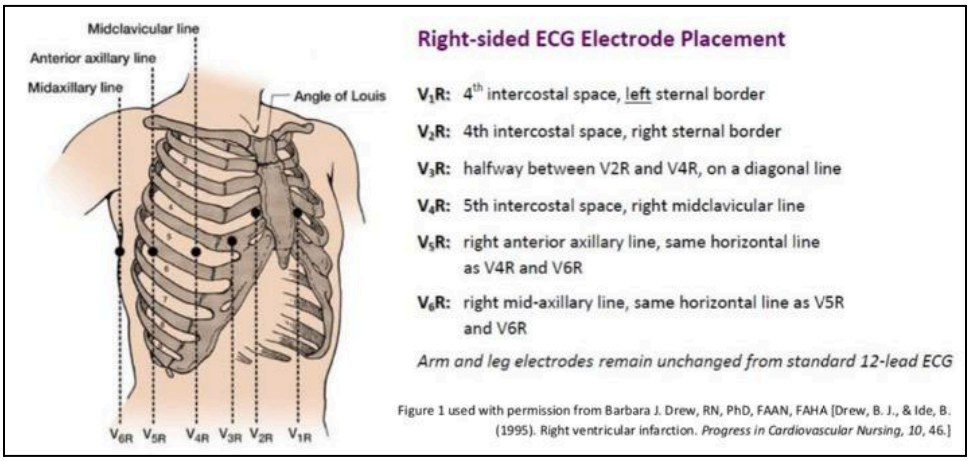
pattern seen	blood supply	area affected	other structures that may be affected	adjust treatment	possible complications
wellens	re-perfused, prox. left ant. descending (LAD)	anterior	bundle branches, anterior fascicle, septum	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs; ventricular dysrhythmia
hyperacute T-waves	(correlate with leads where changes are seen)	(varies)	(varies)	(varies)	(varies)
de winter T-waves	prox. left ant. descending (LAD)	anterior	bundle branches, anterior fascicle, septum	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs, ventricular dysrhythmia
aslanger pattern	right coronary (RCA) left circumflex (LCX)	inferior	SA node, AV node, papillary muscles	caution with nitrates, fluids for hypotension, consider right-sided view	RV infarct, papillary muscle rupture/ mitral regurgitation; bradycardia, AV block
south african Flag	first diagonal branch of left ant. descending (LAD)	anterolateral/ high lateral	conduction system, papillary muscles	consider listening to HTs	LV dysfunction, cardiogenic shock, heart failure/ pulmonary edema, LV thrombus; ventricular dysrhythmia
new onset bifasc. block w/ RBBB	prox. left ant. descending (LAD)	anterior	bundle branches, anterior fascicle, septum	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs, ventricular dysrhythmia
posterior OMI	left circumflex (LCX) right coronary (RCA)	posterior	SA node, AV node, papillary muscles	consider posterior view consider listening to HTs, consider right-sided and inferior involvement	RV infarct, papillary muscle rupture/ mitral regurgitation; bradycardia, AV block
terminal QRS distortion (V2-V3)	left ant. descending (LAD)	anterior	conduction system, papillary muscles	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, heart failure/ pulmonary edema, LV thrombus; ventricular dysrhythmia
sgarbossa	(correlate with leads where changes are seen)	(varies)	(varies)	(varies)	(varies)
precordial swirl	prox. left ant. descending (LAD)	anterior	LV wall, papillary muscles	caution with fluid administration if needed	LV dysfunction, papillary muscle rupture/ mitral regurgitation, cardiogenic shock; ventricular dysrhythmia
northern OMI	left ant. descending (LAD) & 1st diagonal bifurcation	anterior	LV wall, papillary muscles	caution with fluid administration if needed	LV dysfunction, papillary muscle rupture/ mitral regurgitation
shark fin	prox. left ant. descending (LAD)	anterior	conduction system, papillary muscles	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs, ventricular dysrhythmia
aVR ST elevation	left main, prox. left ant. descending (LAD) or 3x vessel	anterior & lateral (L main) anterior & septal (LAD) can be global (multi vessel)	LV wall, conduction system	consider listening to HTs	LV dysfunction, cardiogenic shock; AV block, BBBs, ventricular dysrhythmia
subtle stuff	(correlate with leads where changes are seen)	most likely inferior or lateral	(varies)	(varies)	(varies)

*difficult to see, so either open it here & zoom in as needed or see abridged version below

Return to Contents

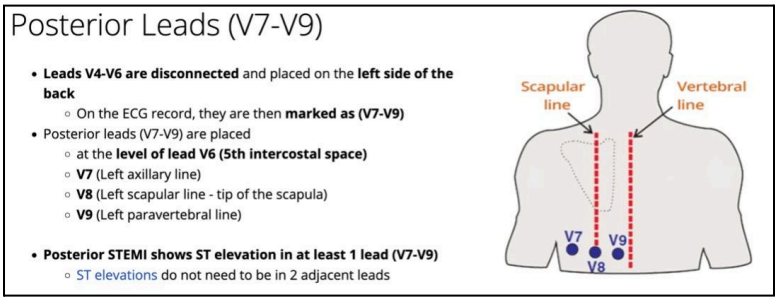
pattern seen	other structures that may be affected	adjust treatment	possible complications
wellens	bundle branches, anterior fascicle, septum	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs; ventricular dysrhythmia
hyperacute T-waves	(varies)	(varies)	(varies)
de winter T-waves	bundle branches, anterior fascicle, septum	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs, ventricular dysrhythmia
aslanger pattern	SA node, AV node, papillary muscles	caution with nitrates, fluids for hypotension, consider right-sided view	RV infarct, papillary muscle rupture/ mitral regurgitation; bradycardia, AV block
south african Flag	conduction system, papillary muscles	consider listening to HTs	LV dysfunction, cardiogenic shock, heart failure/ pulmonary edema, LV thrombus; ventricular dysrhythmia
new onset bifasc. block w/ RBBB	bundle branches, anterior fascicle, septum	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs, ventricular dysrhythmia
posterior OMI	SA node, AV node, papillary muscles	consider posterior view consider listening to HTs, consider right-sided and inferior involvement	RV infarct, papillary muscle rupture/ mitral regurgitation; bradycardia, AV block
terminal QRS distortion (V2-V3)	conduction system, papillary muscles	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, heart failure/ pulmonary edema, LV thrombus; ventricular dysrhythmia
sgarbossa	(varies)	(varies)	(varies)
precordial swirl	LV wall, papillary muscles	caution with fluid administration if needed	LV dysfunction, papillary muscle rupture/ mitral regurgitation, cardiogenic shock; ventricular dysrhythmia
northern OMI	LV wall, papillary muscles	caution with fluid administration if needed	LV dysfunction, papillary muscle rupture/ mitral regurgitation
shark fin	conduction system, papillary muscles	caution with fluid administration if needed	LV dysfunction, cardiogenic shock, acute VSD; AV block, BBBs, ventricular dysrhythmia
aVR ST elevation	LV wall, conduction system	consider listening to HTs	LV dysfunction, cardiogenic shock; AV block, BBBs, ventricular dysrhythmia
subtle stuff	(varies)	(varies)	(varies)

4. Perform additional actions if needed
    a. Right-sided EKG


Midclavicular line
Anterior axillary line
Midaxillary line
Angle of Louis
V6R V5R V4R V3R V2R V1R
Right-sided ECG Electrode Placement
V1R: 4th intercostal space, left sternal border
V2R: 4th intercostal space, right sternal border
V3R: halfway between V2R and V4R, on a diagonal line
V4R: 5th intercostal space, right midclavicular line
V5R: right anterior axillary line, same horizontal line as V4R and V6R
V6R: right mid-axillary line, same horizontal line as V5R and V6R
Arm and leg electrodes remain unchanged from standard 12-lead ECG
Figure 1 used with permission from Barbara J. Drew, RN, PhD, FAAN, FAHA [Drew, B. J., & Ide, B. (1995). Right ventricular infarction. Progress in Cardiovascular Nursing, 10, 46.]

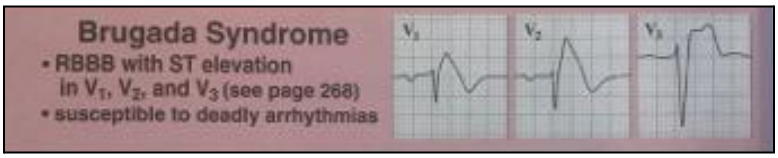
Return to Contents

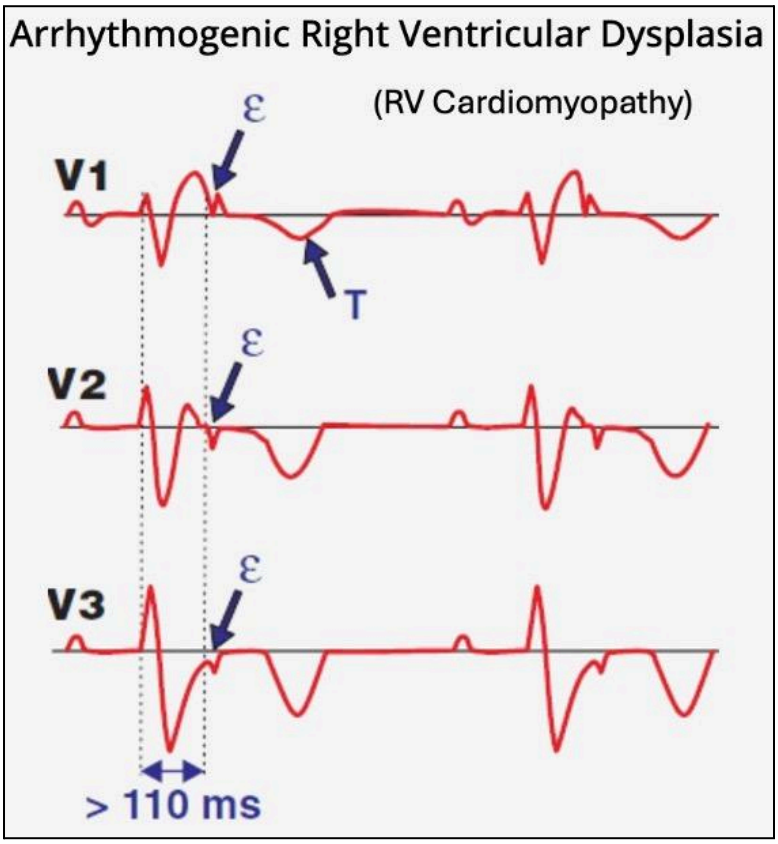
b. Posterior EKG


Posterior Leads (V7-V9)
• Leads V4-V6 are disconnected and placed on the left side of the back
◦ On the ECG record, they are then marked as (V7-V9)
• Posterior leads (V7-V9) are placed
◦ at the level of lead V6 (5th intercostal space)
◦ V7 (Left axillary line)
◦ V8 (Left scapular line - tip of the scapula)
◦ V9 (Left paravertebral line)
• Posterior STEMI shows ST elevation in at least 1 lead (V7-V9)
◦ ST elevations do not need to be in 2 adjacent leads
Scapular line
Vertebral line
V7
V8
V9

5. Evaluate any additional findings

a. 12-lead patterns with predisposition to lethal arrhythmias





Return to Contents

ECG and Hypertrophic Cardiomyopathy

Hypertrophic Cardiomyopathy (HCM) **does not have specific ECG diagnostic criteria**

- **ECG in HCM is always abnormal**
- Diagnosis is based on echocardiography ← **consider POCUS**

Most common ECG changes in hypertrophic cardiomyopathy

- Left Ventricular Hypertrophy (and non-specific ST and T wave changes)
  - Right Ventricular Hypertrophy
- P mitrale (Left Atrial Hypertrophy) (due to diastolic dysfunction of the left ventricle in HCM)
  - P pulmonale (Right Atrial Hypertrophy)
- Pathological Q wave (caused by hypertrophy of the ventricular septum)
  - **Located in lateral leads** (I, aVL, V5-V6) **and inferior leads** (II, III, aVF)
  - Usually **width < 40ms** (not always the case)
  - Q wave can mimic a previous myocardial infarction
    - Q wave after infarction has a width > 40ms
- WPW Syndrome (33% of HCM patients have WPW syndrome)
  - Genetic mutations often cause both conditions simultaneously
- **Deep negative T waves (V2-V6)**
  - Occur in **apical HCM**
  - However, this apical HCM is very rare
    - It mainly occurs in Japan, affecting about 20% of HCM patients
- Ventricular Tachycardia
- Ventricular Extrasystoles

Early Repolarization

Definition:

Early repolarization is defined by the presence of QRS notching (A) or slurring (B), where the peak of the notch or slur onset (J peak or J_p) is at least 1mm or 0.1 mV or greater. Of note, early repolarization does not require the presence of ST segment elevation.

Distribution:

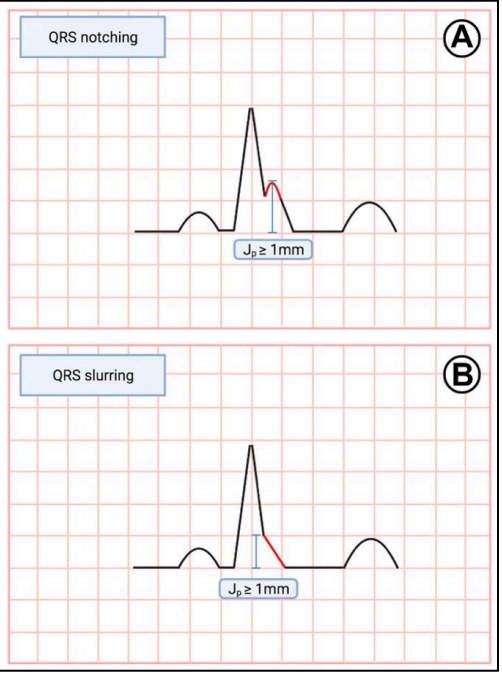
Most commonly seen in the lateral (V5, V6) leads, followed by inferior (II, III, aVF).

Epidemiology:

6-12% in the general population. Higher prevalence among males.

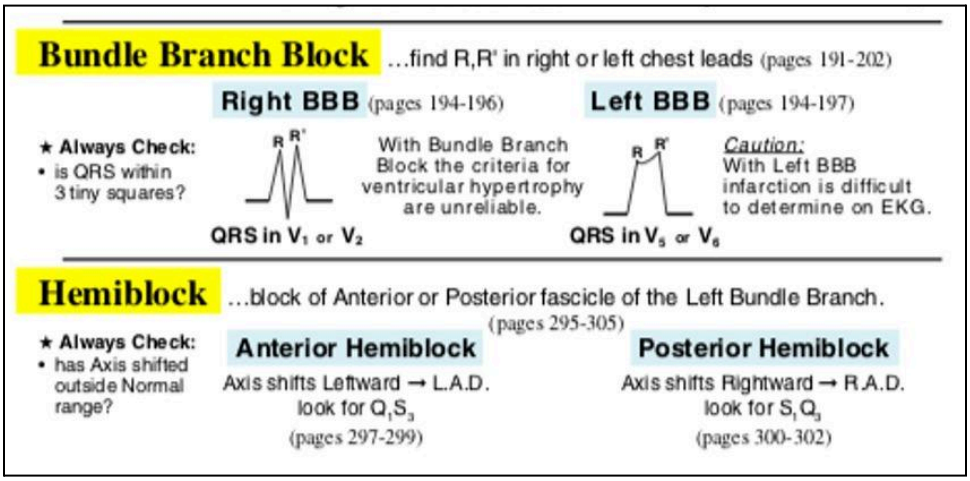
Significance:

Associated with 30% increase in relative risk of cardiac death compared to those without early repolarization, although the absolute risk remains small.

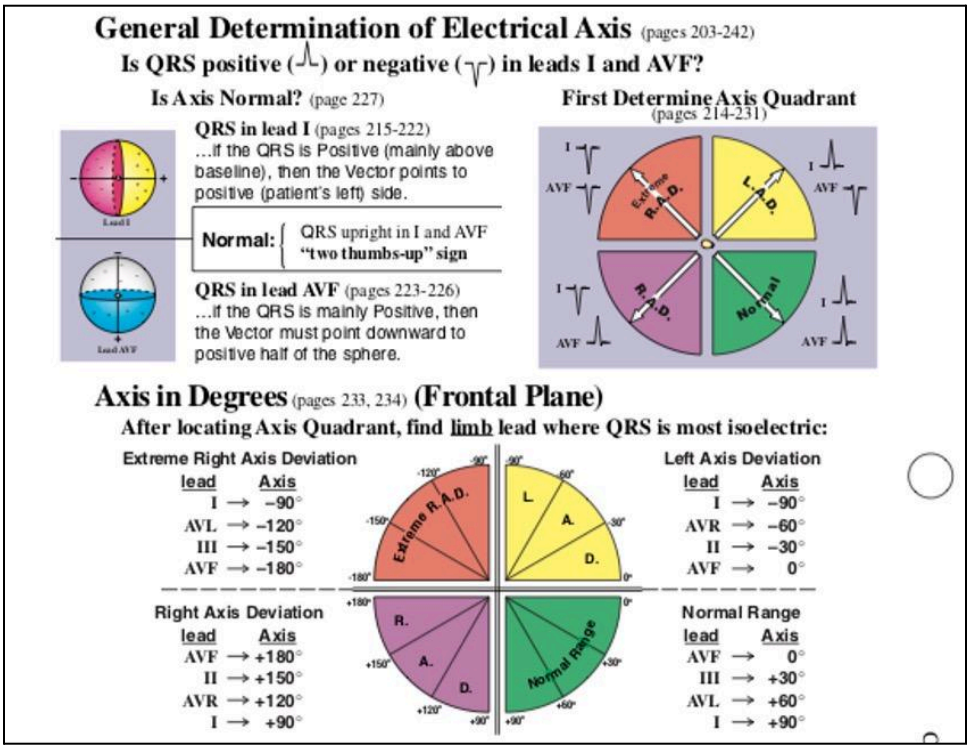


Return to Contents

b. Bundle branch blocks


Bundle Branch Block ...find R,R' in right or left chest leads (pages 191-202)
Right BBB (pages 194-196)
Left BBB (pages 194-197)
★ Always Check:
• is QRS within 3 tiny squares?
R R'
With Bundle Branch Block the criteria for ventricular hypertrophy are unreliable.
R R'
Caution:
With Left BBB infarction is difficult to determine on EKG.
QRS in V1 or V2
QRS in V5 or V6
Hemiblock ...block of Anterior or Posterior fascicle of the Left Bundle Branch.
(pages 295-305)
★ Always Check:
• has Axis shifted outside Normal range?
Anterior Hemiblock
Axis shifts Leftward → L.A.D.
look for Q1S3
(pages 297-299)
Posterior Hemiblock
Axis shifts Rightward → R.A.D.
look for S1Q3
(pages 300-302)

c. Axis deviation


General Determination of Electrical Axis (pages 203-242)
Is QRS positive (⅃) or negative (⅂) in leads I and AVF?
Is Axis Normal? (page 227)
QRS in lead I (pages 215-222)
...if the QRS is Positive (mainly above baseline), then the Vector points to positive (patient's left) side.
Normal: QRS upright in I and AVF
"two thumbs-up" sign
QRS in lead AVF (pages 223-226)
...if the QRS is mainly Positive, then the Vector must point downward to positive half of the sphere.
First Determine Axis Quadrant
(pages 214-231)
Extreme R.A.D.
L.A.D.
R.A.D.
Normal
Axis in Degrees (pages 233, 234) (Frontal Plane)
After locating Axis Quadrant, find limb lead where QRS is most isoelectric:
Extreme Right Axis Deviation
lead Axis
I → −90°
AVL → −120°
III → −150°
AVF → −180°
Left Axis Deviation
lead Axis
I → −90°
AVR → −60°
II → −30°
AVF → 0°
Right Axis Deviation
lead Axis
AVF → +180°
II → +150°
AVR → +120°
I → +90°
Normal Range
lead Axis
AVF → 0°
III → +30°
AVL → +60°
I → +90°

Return to Contents

Right Axis Deviation

- Right Ventricular Hypertrophy
- Pulmonary Embolism (Acute Right Heart Overload)
- Lateral STEMI
- Chronic Obstructive Pulmonary Disease (COPD)
- Hyperkalemia
- Tricyclic Antidepressants (Intoxication)
- WPW Syndrome
- Dextrocardia
- Left Posterior Hemiblock
- Ventricular Extrasystole
- Normal Variant in Children
- Vertical Heart Position (Slim and Tall Patients)

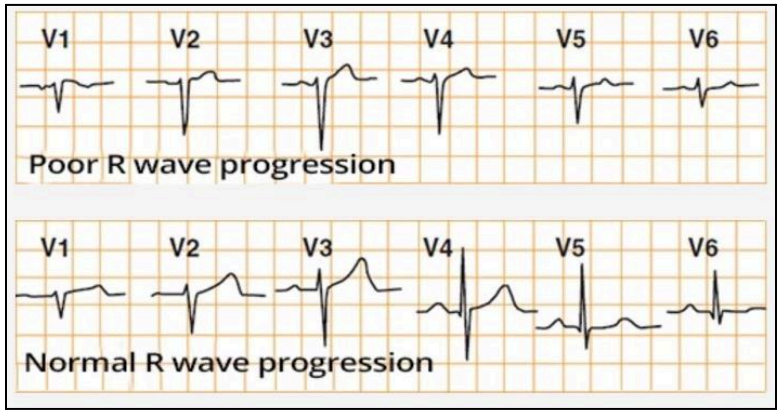
Left Axis Deviation

- Left Anterior Fascicular Block
- Left Tawara Branch Block
- Left Ventricular Hypertrophy
- Inferior STEMI
- Ventricular Extrasystole
- Pacemaker Rhythm
- WPW Syndrome

Extreme Axis Deviation

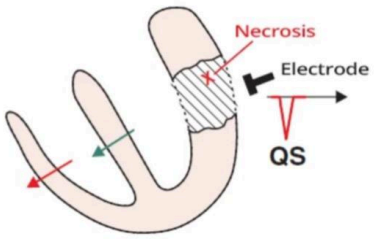
- Ventricular Tachycardia
- Hyperkalemia
- Severe Right Ventricular Hypertrophy

d. R wave progression



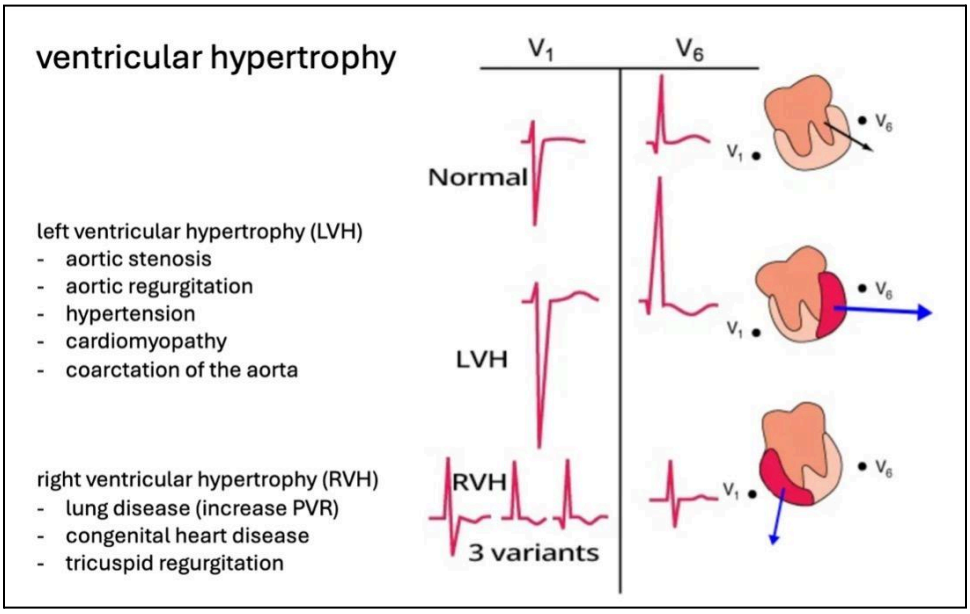
Causes of Decreased R Wave Progression

- Old Antero-septal Infarction
  - (Most common cause of decreased R wave progression)
- Left Ventricular Hypertrophy
- Switched ECG leads V1 with V3
- Dilated Cardiomyopathy
- Left Tawar's Bundle Block
- WPW Syndrome
- Dextrocardia
- It may be a normal variant

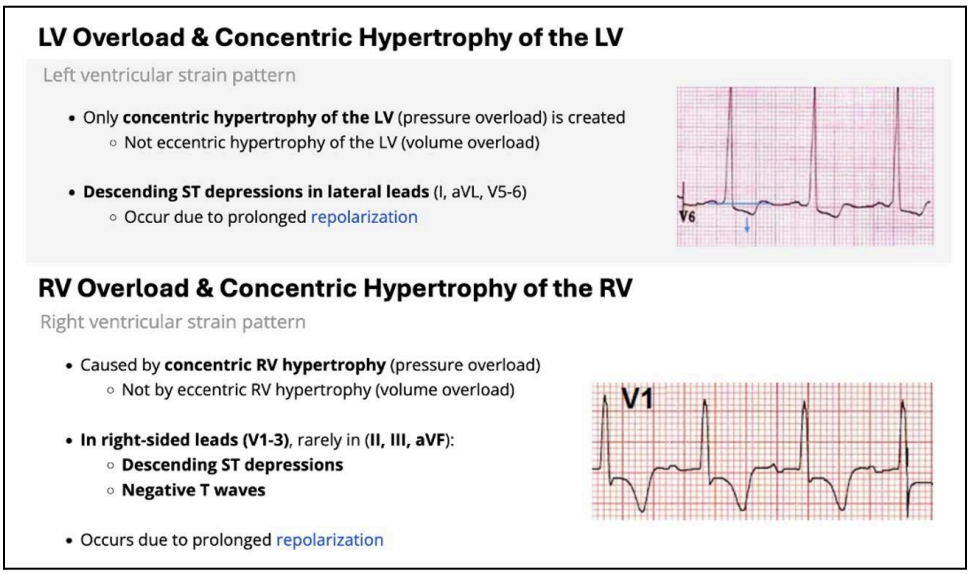


Return to Contents

e. Hypertrophy



f. Strain patterns


LV Overload & Concentric Hypertrophy of the LV
Left ventricular strain pattern
• Only concentric hypertrophy of the LV (pressure overload) is created
◦ Not eccentric hypertrophy of the LV (volume overload)
• Descending ST depressions in lateral leads (I, aVL, V5-6)
◦ Occur due to prolonged repolarization
V6
RV Overload & Concentric Hypertrophy of the RV
Right ventricular strain pattern
• Caused by concentric RV hypertrophy (pressure overload)
◦ Not by eccentric RV hypertrophy (volume overload)
• In right-sided leads (V1-3), rarely in (II, III, aVF):
◦ Descending ST depressions
◦ Negative T waves
V1
• Occurs due to prolonged repolarization

Return to Contents

References

Blahut, Peter. “Free Online ECG Book.” *ECGbook*, ECGbook.com, 30 July 2024, www.ecgbook.com/.

Buttner, Robert, and Ed Burns. “ST Elevation in AVR.” *Life in the Fast Lane • LITFL*, 1 Aug. 2020, litfl.com/st-elevation-in-avr/.

Chilazi, Michael, et al. “Sudden Cardiac Arrest Secondary to Early Repolarization Syndrome.” *JACC Case Reports*, vol. 3, no. 12, 1 Sept. 2021, pp. 1422–1426, https://doi.org/10.1016/j.jaccas.2021.07.006.

Dubin, Dale. *Rapid Interpretation of EKG's : Dr Dubin's Classic, Simplified Methodology for Understanding EKG's*. Tampa, Cover Publishing, 2016.

Escabi-Mendoza, Jose, et al. “Shark Fin Occlusive Myocardial Infarction ECG Pattern Post-Cardiac Arrest Misinterpreted as Ventricular Tachycardia.” *Cureus*, 8 May 2023, pmc.ncbi.nlm.nih.gov/articles/PMC10246928/, https://doi.org/10.7759/cureus.38708.

FoamFrat. “Gotta Catch 'Em All - STEMI Equivalents.” *FOAMfrat*, 28 Feb. 2021, www.foamfrat.com/post/gotta-catch-em-all-stemi-equivalents.

Magnus Nossen. “A 35-Year Old Woman with This Post-ROSC ECG. What Does “Shark Fin” Morphology Mean? - Dr. Smith’s ECG Blog.” *Dr. Smith’s ECG Blog*, 8 Aug. 2025, drsmithsecgblog.com/a-35-year-old-woman-with-this-post-rosc-ecg-what-does-shark-fin-morphology-mean/.

Mahmoud Alkatib, et al. “Cardiac Arrhythmias in STEMI Patients in ICU: Study on Occurrence in First 48 Hours and Correlation with Age, Sex, Infarction Site, and Risk Factors.” *Annals of Medicine and Surgery*, vol. 85, no. 10, 5 Sept. 2023, pp. 4824–4829, www.ncbi.nlm.nih.gov/pmc/articles/PMC10553150/#:~:text=Different%20factors%20play%20a%20role, https://doi.org/10.1097/ms9.0000000000001264.

Ricci, Fabrizio, et al. “ECG Patterns of Occlusion Myocardial Infarction: A Narrative Review.” *Annals of Emergency Medicine*, vol. 85, no. 4, 17 Jan. 2025, www.sciencedirect.com/science/article/pii/S0196064424012502, https://doi.org/10.1016/j.annemergmed.2024.11.019.

Shah, Jehangir A, et al. “Incidence of Cardiac Arrhythmias in Acute Myocardial Infarction Patients Undergoing Primary Percutaneous Coronary Intervention and Associated Outcomes during the First 24 Hours.” *Cureus*, vol. 13, no. 1, 10 Jan. 2021, https://doi.org/10.7759/cureus.12599.

Smith, Steve. ““Shark Fin”: A Deadly ECG Sign That You Must Know! - Dr. Smith’s ECG Blog.” *Dr. Smith’s ECG Blog*, 11 June 2018, drsmithsecgblog.com/shark-fin-deadly-ecg-sign-that-you-must/.

Simon Mark Daily. “STEMI Mimics; a Mnemonic.” *Fab NHS Stuff*, 2018, fabnhsstuff.net/fab-stuff/stemi-mimics-a-mnemonic.

“The Ultimate ECG Book & Course: Learn ECG Interpretation, Videos, Test/Quiz.” *ECG & ECHO*, ecgwaves.com/.